CLAIMS

1. An apparatus for processing one or more semiconductor wafers, comprising:
a module for storing a wafer;
a plurality of vertically stacked processing modules for at least one of electropolishing the wafer and electroplating the wafer;
a cleaning module; and
a robot for transferring the wafer between the module for storing, the processing module, and the cleaning module,
wherein the apparatus is divided into at least two sections characterized by separate frames.

2. The apparatus of claim 1, further including a pre-alignment module to align the wafer prior to processing.

3. The apparatus of claim 1, wherein the robot includes one or more end effectors for picking and transferring the wafer.

4. The apparatus of claim 1, wherein the robot is removable by rolling or sliding out from one of the at least two sections.

5. The apparatus of claim 1, wherein the robot includes,
a first end effector for transferring the wafer to the processing modules, and
a second end effector for transferring the wafer from the processing modules.

6. The apparatus of claim 1, further including a liquid delivery system for delivering process liquid to the processing modules.

7. The apparatus of claim 6, wherein the liquid delivery system includes a surge suppressor.

8. The apparatus of claim 6, wherein the liquid delivery system includes a controller to modulate a flow rate of the process liquid.

9. The apparatus of claim 6, wherein the liquid delivery system is housed in a containment tray.

10. The apparatus of claim 1, wherein the apparatus includes an exhaust to remove gases from the processing modules.

11. A method for at least one of electropolishing and electroplating a semiconductor wafer in a process assembly, comprising:
transferring a wafer to one of a plurality of stacked processing modules with a first end effector;
electropolishing or electroplating the wafer in the processing module;
transferring the wafer from the processing module to a cleaning module with a second end effector; and
cleaning the wafer in the cleaning module, wherein the process assembly is divided into at least two sections characterized by separate frames.

12. The method of claim 11, further wherein transferring the wafer includes using a robot and wherein the robot is configured to slide or roll out of the process assembly.

13. The method of claim 11, further including delivering liquid to the processing module through a supply line, wherein a surge suppressor is associated with the supply line.

14. The method of claim 11, further including removing gases from the processing module through an exhaust system.

15. An apparatus for holding a semiconductor wafer, comprising:
an aperture located on one side of an end effector member;
a passage coupled to the aperture for evacuating gas from the aperture; and
a cup disposed around the aperture configured to create a temporary seal between the end effector and the semiconductor wafer when gas is evacuated from the aperture.

16. The apparatus of claim 15, further including a cap having a groove formed therein, the cap being disposed over the aperture.

17. The apparatus of claim 16, wherein the cap is shaped as a circle.

18. The apparatus of claim 15, further including two or more apertures coupled to the vacuum passage.

19. The apparatus of claim 15, further including two or more apertures coupled to the vacuum passage and within a single cup.

20. The apparatus of claim 15, wherein the cup includes a flexible material.

21. The apparatus of claim 15, wherein the cup includes an elastomer material.

22. The apparatus of claim 15, wherein the cup extends away from the surface of the end effector member.

23. The apparatus of claim 15, wherein the cup is shaped as a circle.

24. The apparatus of claim 15, wherein the cup is shaped as an elongated circle.

25. The apparatus of claim 15, wherein the cup is shaped as a horseshoe.

26. The apparatus of claim 15, wherein the end effector is mechanically coupled to a robot and the cup is disposed at a distal end of the end effector.

27. The apparatus of claim 15, wherein a distal end of the end effector is horseshoe shaped.

28. The apparatus of claim 15, wherein the vacuum passage is formed integral with the body of the end effector.

29. The apparatus of claim 15, wherein the vacuum passage is coupled to a vacuum source.

30. The apparatus of claim 29, wherein the vacuum passage is further coupled to a gas source for introducing gas into the vacuum passage.

31. A method for holding a semiconductor wafer, comprising:
positioning an end effector in proximity to a major surface of a wafer;
evacuating a flexible cup disposed on a major surface of the end effector opposite the major surface of the wafer; and
creating a temporary seal between the vacuum cup and the wafer.

32. The method of claim 31, wherein the flexible cup is adjacent an upper major surface of the wafer and is evacuated sufficiently to hold the wafer against gravity.

33. The method of claim 31, wherein the flexible cup is adjacent a lower major surface of the wafer and is evacuated to a lower pressure relative to a surrounding environment.

34. The method of claim 31, wherein the flexible cup is circular in shape.

35. The method of claim 31, further including introducing gas into the flexible cup to release the wafer.

36. The method of claim 31, wherein the flexible cup is evacuated through an aperture formed in the cavity.

37. The method of claim 31, wherein the flexible cup includes a cap disposed over the aperture, the cap having a groove formed therein.

38. An apparatus for cleaning a semiconductor wafer, comprising:
a wafer edge clean assembly including a nozzle head configured to supply a liquid and a gas to a major surface of a wafer, wherein,
the liquid is supplied adjacent the outer edge of the major surface of the wafer, and
the gas is supplied radially inward of the location the liquid is supplied.

39. The apparatus of claim 38, wherein the gas and liquid are supplied from adjacent nozzles.

40. The apparatus of claim 38, wherein the gas is nitrogen gas and the liquid includes a metal etching chemical.

41. The apparatus of claim 38, wherein the nozzle is configured to supply the gas to prevent the liquid from spreading radially inward on the major surface of the wafer.

42. The apparatus of claim 38, wherein the nozzle is configured to supply the gas in the form of a curtain of gas to prevent the liquid from traversing the gas.

43. The apparatus of claim 38, wherein the nozzle includes a horizontal span parallel to the major surface of the wafer to create a gas barrier between the horizontal span and the opposing major surface of the wafer.

44. The apparatus of claim 43, wherein the distance between the horizontal span and the major surface of the wafer is approximately .1 mm to 2.0 mm.

45. The apparatus of claim 43, wherein the distance between the horizontal span and the major surface of the wafer is approximately 1.5 mm.

46. The apparatus of claim 38, further including a chuck to rotate the wafer adjacent the nozzle.

47. The apparatus of claim 46, wherein the chuck assembly includes positioners configured to secure the wafer as the chuck rotates.

48. The apparatus of claim 47, wherein the positioners include a first portion and a second portion mechanically coupled and the first portion has a greater mass than the second portion such that during rotation the first portion moves outward and the second portion moves inward to secure the wafer.

49. The apparatus of claim 48, wherein the positioners include an axis of rotation and the first portion is positioned below the axis of rotation and the second portion is positioned above the axis of rotation.

50. A method for cleaning semiconductor wafers, comprising:
an edge clean process including,
rotating a wafer about a central axis;
directing a fluid to a major surface of the wafer; and
directing a gas to the major surface of the wafer located adjacent to and radially inward of the location the etching fluid is directed.

51. The method of claim 50, wherein the gas reduces the potential for fluid to flow radially inward on the semiconductor wafer.

52. The method of claim 50, wherein the gas and liquid are supplied simultaneously.

53. The method of claim 50, wherein the gas is directed to the wafer prior to and during the process of directing the fluid to the wafer.

54. The method of claim 50, wherein the gas is directed to the wafer during and after the process of directing the fluid to the wafer.

55. The method of claim 50, wherein the gas includes nitrogen gas and the liquid includes a metal etching chemical.

56. The method of claim 50, wherein the liquid is supplied to a bevel region on the major surface of the wafer.

57. The method of claim 56, wherein the gas is supplied to the radial inside edge of the bevel region.

58. The method of claim 50, wherein the gas is supplied in a region adjacent the location the liquid is supplied, the region having a width in the radial direction and a length in the circumferential direction to reduce the potential for liquid to flow radially inward on the wafer.

59. The method of claim 50, wherein the chuck rotates the wafer between approximately 50 and 500 rpm during the edge clean process.

60. The method of claim 50, wherein the chuck rotates the wafer approximately 350 rpm during the edge clean process.

61. The method of claim 50, further including supplying DI water to both major surfaces of the wafer.

62. The method of claim 50, further including drying the wafer by rotating the wafer between approximately 1,000 and 3,000 rpm and supplying streams of gas to the major surface of the wafer.

63. The method of claim 50, further including directing a liquid to the backside of the wafer in one-third intervals while oscillating the wafer such that the liquid does not directly contact positioners holding the wafer.

64. The method of claim 50, further including directing a liquid to the backside of the wafer in pulses such that the liquid does not directly contact positioners holding the wafer.

65. The method of claim 50, further including rotating a chuck holding the wafer with a sufficient acceleration such that the wafer shifts relative to the chuck and repeating a cleaning process.

66. A method for determining the positioning of a wafer on a chuck, comprising:
rotating a wafer positioned on a chuck;
measuring a characteristic of a major surface of the wafer with a sensor as the wafer is rotated; and
determining if the wafer is positioned correctly based on the measured characteristic.

67. The method of claim 66, wherein the sensor is an optical sensor that measures the reflectivity of light from the surface of the wafer.

68. The method of claim 66, wherein if the reflectivity varies below a threshold value determining that the wafer is not positioned correctly on the chuck.

69. The method of claim 66, wherein the sensor is a proximity sensor that measures a distance between the sensor and the wafer surface.

70. The method of claim 66, wherein the sensor is an acoustic sensor.

71. The method of claim 66, wherein the sensor is an eddy current sensor.

72. A process chamber for an electropolishing process or an electroplating process of a semiconductor wafer, comprising:
a chuck assembly for positioning a wafer opposite a processing nozzle that is configured to dispense a processing liquid to a major surface of the wafer, wherein the chuck assembly translates in a first direction relative to the processing nozzle when processing a wafer; and
a shroud mechanically coupled to the chuck assembly such that the shroud translates with the chuck assembly.

73. The apparatus of claim 72, wherein the shroud is magnetically coupled to the chuck assembly.

74. The apparatus of claim 72, wherein the chuck assembly translates in a second direction perpendicular to the first direction to adjust the location that the liquid is dispensed on the wafer.

75. The apparatus of claim 72, wherein during an electropolishing process the chuck assembly positions the major surface of the wafer a distance of approximately 0.5 mm to 10 mm from the nozzle.

76. The apparatus of claim 75, wherein the distance is approximately 5 mm.

77. The apparatus of claim 72, wherein during an electroplating process the chuck assembly positions the major surface of the wafer a distance of approximately 0.5 mm to 20 mm from the nozzle.

78. The apparatus of claim 77, wherein the distance is approximately 5 mm.

79. The apparatus of claim 72, further including an optical sensor and an end-point detector configured to measure a metal layer on the major surface of the wafer.

80. The apparatus of claim 72, wherein the chuck assembly is magnetically coupled with the process chamber.

81. The apparatus of claim 80, wherein the chuck assembly may disengage with the process chamber.

82. An electroplating or electropolishing apparatus, comprising:
a nozzle for directing a stream of processing liquid,
an energy element configured to enhance the agitation of process fluid at a metal film surface.

83. The apparatus of claim 82, wherein the energy element is mechanically coupled to the nozzle.

84. The apparatus of claim 82, wherein the energy element includes at least one of an ultrasonic transducer, magnasonic transducer, laser source, infrared heat source, microwave source, and magnet source.

85. The apparatus of claim 82, wherein energy element includes an ultrasonic transducer configured to operate in a range of 15 KHz and 100 Mega Hz.

86. The apparatus of claim 82, wherein energy element includes a laser configured to operate in a range of 1 to 100 W/cm^2, wherein the laser is directed to a surface of a metal film on a wafer.

87. The apparatus of claim 82, further including determining the metal film thickness by stimulating ultra sonic waves with a laser.

88. The apparatus of claim 82, wherein energy element includes an infrared source configured to operate in a range of 1 to 100 W/cm^2, wherein infrared source is directed to a surface of a metal film on a wafer.

89. The apparatus of claim 82, further including an infrared sensor to measure the surface temperature of the metal film surface.

90. The apparatus of claim 82, wherein energy element includes a magnetic source configured to focus an electric current in the process fluid at a surface of a metal film on a wafer.

91. A method for electropolishing or electroplating a metal layer on a semiconductor wafer, comprising the acts of:
rotating a wafer chuck holding a wafer;
directing a stream of processing fluid to a metal layer on a surface of a wafer;
translating the wafer with respect to the stream of processing fluid; and
translating a shroud with the wafer, wherein the shroud and wafer chuck are mechanically coupled.

92. The method of claim 91, wherein the shroud and wafer chuck are magnetically coupled and capable of disconnecting.

93. The method of claim 91, wherein the wafer is translated in a direction parallel to the major surface of the wafer and rotated at a constant linear velocity.

94. The method of claim 91, further including measuring a reflectivity of the metal layer with an end-point detector and creating a metal film thickness profile.

95. The method of claim 91, further including adjusting the current flow based on a determined metal film thickness profile.

96. The method of claim 91, wherein an electropolishing process includes
a) determining a desired thickness of a metal film on the wafer,
b) removing a portion of the metal film on the wafer,
c) measuring the thickness of the metal film, and
d) if the metal film thickness is greater than the desired thickness repeating b), c), and d) until the desired thickness is measured.

97. The method of claim 96, wherein the metal film thickness is measured with an end-point detector.

98. The method of claim 96, wherein the metal film thickness is determined by measuring ultrasonic waves produced by directing a laser to the metal film surface.

99. The method of claim 96, further including electroplating the wafer if it is determined in c) that the metal film thickness is too thin.

100. The method of claim 91, wherein in an electropolishing process, the rotation speed of the chuck is varied in relation to a linear travel distance between the wafer and a nozzle parallel to the major surface of the wafer.

101. The method of claim 91, wherein in an electropolishing process, the rotation speed of the chuck is varied in relation to a current density of an electropolishing process liquid.

102. The method of claim 91, wherein in an electropolishing process, the rotation speed of the chuck is varied in relation to the measured metal film thickness profile, the desired thickness profile, and a location of the wafer being polished.

103. The method of claim 91, wherein the chuck is rotated in a constant linear velocity mode.

104. The method of claim 91, wherein the chuck is rotated in a constant rotation mode.

105. The method of claim 91, wherein the chuck is rotated in a constant centrifugal force mode.

106. An apparatus for electroplating a wafer, comprising:

a shower head for dispensing a process liquid, including:

an inlet for receiving the process fluid,

a channel associated with the inlet and disposed between the inlet and a plurality of orifices, and

a filter element, wherein the filter element is disposed in the channel to distribute the process fluid entering the inlet throughout the channel and to flow from the plurality of orifices uniformly.

107. The apparatus of claim 106, further including a plurality of channels disposed between a plurality of inlets and a plurality of orifices with at least one inlet associated with each channel, and

a plurality of filter elements to distribute the processing fluid throughout each channel.

108. The apparatus of claim 106, wherein the filter element is disposed opposite the inlet.

109. The apparatus of claim 106, wherein the filter element is a blocker plate disposed opposite the inlet.

110. The apparatus of claim 106, wherein the shower head is configured for a 300mm wafer or a 200mm wafer.

111. The apparatus of claim 106, further including electrode rings disposed adjacent the plurality of orifices and exterior to the channel.

112. The apparatus of claim 111, wherein the electrode rings include anticorrosive metals or alloys

113. The apparatus of claim 111, further including a nozzle head with a plurality of nozzle apertures positioned over the shower head electrode rings.

114. The apparatus of claim 112, wherein the plurality of nozzle apertures are offset with respect to the plurality of orifices.

115. A method for electroplating a semiconductor wafer, comprising the acts of:

receiving a process liquid through an inlet in a channel, wherein the channel includes a plurality of apertures for dispensing the process liquid; and

distributing the process liquid received through the inlet throughout the channel so that it passes through the plurality of orifices uniformly.

116. The method of claim 115, further including receiving a process liquid at a plurality of channels disposed between a plurality of inlets and a plurality of orifices with at least one inlet associated with each channel, and

distributing the process liquid received throughout each channel.

117. The method of claim 115, wherein the process liquid is electrolyte fluid.

118. The method of claim 115, wherein the process liquid is distributed by a filter element disposed opposite the inlet.

119. The method of claim 118, wherein the filter element is a blocker plate.

120. The method of claim 115, further including electroplating a 300mm wafer or a 200mm wafer.

121. The method of claim 115, further including passing the process fluid over electrode rings after the process fluid has been dispensed from the plurality of orifices.

122. The method of claim 121, wherein the electrode rings include anticorrosive metals or alloys.

123. The method of claim 121, further including passing the process fluid through a nozzle head including a plurality of nozzle apertures, the nozzle head positioned over the electrode rings.

124. The method of claim 123, further including offsetting the plurality of nozzle apertures with respect to the plurality of orifices.

125. The method of claim 123, wherein the process fluid flow is distributed within a channel by the filter element, flows uniformly from the plurality of orifices past the electrode rings, and through the nozzle apertures to the surface of a wafer.

126. An apparatus for leveling a semiconductor wafer in a processing device, comprising:
three sensors positioned substantially in a plane; and
a chuck configured to hold a wafer opposite the three sensors, wherein the three sensors are configured to measure distances of the wafer surface relative to the sensors.

127. The apparatus of claim 126, wherein the plane is parallel with a portion of the processing device.

128. The apparatus of claim 126, wherein the plane is associated with a processing nozzle.

129. The apparatus of claim 126, wherein the sensors includes a conductive pin which completes a circuit with a signal line coupled to the sensor, a metal layer on the surface of the wafer, and a ground line coupled to the wafer.

130. The apparatus of claim 129, further including a control system that measures the distance offset of the wafer based on a signal created when the circuit is completed.

131. The apparatus of claim 130, wherein the control system adjusts the chuck based on the distance measurements.

132. A method for leveling a wafer in a processing device, comprising:

determining a desired alignment plane of a wafer;

determining the position of a wafer at three locations relative to the desired alignment plane of the wafer; and

adjusting the wafer based on the determined positions of the wafer and desired alignment plane.

133. The method of claim 132, wherein the plane is parallel with a portion of the processing device.

134. The method of claim 132, wherein the plane is associated with a processing nozzle.

135. The method of claim 132, wherein determining the position of the wafer includes measuring distances with three sensors, each having a conductive pin that completes a circuit with a signal line coupled to the sensor, a metal layer on the surface of the wafer, and a ground line coupled to the wafer metal layer.

136. The method of claim 135, wherein a control system measures the distance offset from the plane based on a signal created when the circuit is completed.

137. The apparatus of claim 136, wherein adjusts the wafer includes moving a chuck holding the wafer based on the distance measurements.